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ABSTRACT

Strategies for affective assessment of individuals in a clinical mathematics setting are discussed. Multiple measurement and rating scales are presented. The author stresses that any assessment program should consider a systematic approach that coordinates several measuring techniques. Information gathered by such techniques can be especially valuable when considering affective growth among primary children. Scores on mathematics attitude scales can be better predictors of choice behavior, individual satisfaction, and perseverance than of achievement. Taking student interests, attitudes, or levels of anxiety into account in designing mathematics achievement measures (tests or lessons) can improve performance. Assessment strategies covered are: observation of pupils: student interviews: Thurstone-type and Likert-type attitude scales: semantic differential techniques: and combinations of the above assessment tools. (MP)

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Affective Assessment Strategies in a Diagnostic Prescriptive (Clinical) Mathematics Setting

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Affective Assessment

Strategies in a Diagnostic-Prescriptive (Clinical) Mathematics Setting

Assessment within the realm of affective education has always been considered a very difficult task. Many have questioned the validity of attempting to measure pupil likes, dislikes, feelings, values, attitudes and/or beliefs. However, it is imperative that mathematics educators recognize the value of systematic affective assessment at the elementary and secondary levels. Clinical mathematics programs have a special concern for affective assessment.

The popularity of clinical instruction in mathematics is evidenced by college and University math clinics, Title I mathematics emphasis, compensatory education, and other local education agency special math programs. These programs point out the concern for systematic remediation and/or enrichment programs based on individual pupil needs. Assessment within a clinical mathematics program often focuses on achievement, as measured by periodic analytic or survey tests. Obviously, a systematic assessment plan within the clinical setting should include measures of affective and cognitive growth or, attitude and achievement measures.

The most common measure of affective growth in mathematics is mathematics attitude assessment. The research in this area is not definitive. Aiken (1970) in a comprehensive review of research related to mathematics attitude indicated a need for

> "more attention to techniques for developing positive attitudes and modifying negative attitudes." (p. 592).

Assessing attitudes toward mathematics may be defined as an attempt to measure a learned predisposition or tendency on the part of an individual to respond positively or negatively to an object, concept, or situation (Aiken, 1970). The most common procedures for assessing mathematics attitude are observational and self-report techniques. A summary and review of these procedures follow:

1) Observation

This technique requires the teacher, clinician, or some other professional to observe pupils and record indices of affective growth. The observation procedure is often suspect since standardization, overt reactions, and quantifying behavior all impede the validity and reliability of the systematic observation process. However, clinical mathematics programs should consider recording systematic observations of behavior related to mathematics and learning as indicators of the receiving and responding levels of affective growth. Figures 1 and 2 present observation forms used in a clinical math program. Either observation form may be completed and filed and used as an affective component within a program of affective assessment. Although observation, as an evaluative tool has always been difficult to justify in quantifiable terms, it remains a useful tool for the trained observer and clinician.

Figure 1
WMC Math Clinic
Individual Observation Chart

Pupil Heather Week of _____

Monday

working well - 10:30 A.M.

completed multiplication contract 2:00 P.M.

had a great day!

Tuesday

very bossy today - 9:30 A.M.

distracting Brett - 10:30 A.M.

work handed in partially complete 2:00 P.M.

today's lost!

Wednesday

absent

Thursday

had interview, didn't really understand division algorithm - 10:30

completed division work - looks great - noon

sleepy this afternoon - 2:00 P.M.

Friday

weekly check-up given - 10:00

check-up completed - 10:30

worked on division contract rest of A.M.

Weekly Summary

attained mastery level A in multiplication

didn't really know division algorithm, seems to be working well in division (Fri.)

had an up and down week behaviorally.

Figure 2
WMC Math Clinic
Group Observation Chart

Group A week of _____

Pupils	Monday	Tuesday	Wednesday	Thursday	Friday
Tom	working well in multiplication	making progress	in argument with Bob. Didn't complete assigned work	working indiv. in mult.	back in group
Barb	having difficulty with 2x1 algorithm	indiv. work and interview	basic mult. facts games - went well	making progress in 2x1 mult.	retention in check-up on subtraction
Sam	Excellent progress in 2x2 multiplication	absent	absent	absent	Absent (called parents P.M.)

2) Self-Report techniques

a) Interview

The interview is an assessment technique particularly well adapted to uncovering attitudes, feelings, and conceptual understandings. The interview technique has been used extensively in clinical settings. The interview is distinguished from other self report techniques by its dependence on an interpersonal relationship. It's likely that traditional research studies would be concerned about the extent to which interpersonal relationships, in an interview, contribute to the validity of data gathered. J. Fred Weaver (1955), and Brownell and Watson (1936) advocated the interview technique to assess cognitive and affective growth in mathematics.

The interview may be a series of structured or open-ended questions. The advantage (clinically) of the interview is that it is possible for the interviewer to be aware of a child's frustration, lack of understanding or interest, and be in a position to clarify, remediate, or at least emphathize.

Figure 3 presents a structured interview format used in a math clinic setting.

Figure 3
WMC Math Clinic
Interview Format

1. Open ended question(s) related to how school, math and/or the clinic has been since the last interview.

2. Open ended question related to clinic mathematics. (Topics which the student may or may not be having difficulty with - since the last interview).

3. Interview Procedure - Sampling Mathematics Skills

   a) Provide 5-7 problems in a content area to which the student has been exposed.

   b) Make sure the student has ample materials to complete the assignment.

   c) Record beginning and ending time, and calculate working time.

   d) The students should (if possible) orally explain each step in solving the problems.

   e) Don't require the student to clarify his/her responses until all work is completed. Don't interrupt if, and when a mistake occurs.

4. Ask student about responses to problems.

5. Ask about level of understanding of the problems

6. Classify errors as

   a) Wrong Operation
   b) Computational Error
   c) Defective Algorithm
   d) Random Response

7. Provide feedback and a rapport level that will assist the student in developing successful strategies and a positive outlook toward learning the content area presented.

8. Interview Summary and student work sample and response to be filed.

b) Attitude Scales - Thurstone

The most common procedure for assessing mathematics attitude is the attitude scale. The Thurstone judgmental type attitude scale includes statements which the respondents check, only if the items express their feelings toward mathematics. Each item has a scale value which is derived during scale construction. Dutton (1954) constructed a Thurstone type scale which he used with pupils from the third grade through undergraduate levels. (Figure 4).

The Thurstone technique for scale development is a rigorous procedure which generally insures content validity and reliability. Edwards (1957) presents a very thorough orientation for development and use of the Thurstone type scale.

Figure 4
Arithmetic Attitude Scale
Wilbur H. Dutton

Check (X) only the statements which express your feeling toward arithmetic

_____ 1. I feel arithmetic is an important part of the school curriculum.
_____ 2. Arithmetic is something you have to do even though it is not enjoyable.
_____ 3. Working with numbers is fun.
_____ 4. I have never liked arithmetic.
_____ 5. Arithmetic thrills me and I like it better than any other subject.
_____ 6. I get no satisfaction from studying arithmetic.
_____ 7. I like arithmetic because the procedures are logical.
_____ 8. I am afraid of doing word problems.
_____ 9. I like working all types of arithmetic problems.
_____ 10. I detest arithmetic and avoid using it at all times.
_____ 11. I have a growing appreciation of arithmetic through understanding its values, applications, and processes.
_____ 12. I am completely indifferent to arithmetic.
_____ 13. I have always liked arithmetic because it has presented me with a challenge.
_____ 14. I like arithmetic but I like other subjects just as well.
_____ 15. The completion and proof of accuracy in arithmetic gave me satisfaction and feelings of accomplishment.

Before scoring your attitude scale, place an (X) on the line below to indicate where you think your general feeling toward arithmetic might be.

11 10 9 8 7 6 5 4 3 2 1

Strongly favor **Neutral** **Strongly against**

Scoring the scale. The scale is designed to show attitudes for or against arithmetic. Each item has a scale value. Individuals will usually have both favorable and unfavorable feelings toward arithmetic. By adding all responses and dividing by the total number of responses, one can secure a general average for each individual. Each test item will provide data for pupil guidance. For example, a pupil may like the logical aspects of arithmetic (No. 7) but will be afraid of word problems (No. 8). Scaled values will also show the intensity of feelings toward arithmetic.

Place the scale value for the items you checked on the test in the left margin of the page. Total all items checked. This will give you an average score on the test. Compare this average with the estimated placement shown on the line indicating your general feeling toward arithmetic. Individual

items will reveal highly favorable or unfavorable attitudes.

Scale Value	Test Item
7.2	1
3.3	2
8.7	3
1.5	4
10.5	5
2.6	6
7.9	7
2.0	8
9.6	9
1.0	10
8.2	11
5.2	12
9.5	13
5.6	14
9.0	15

Dutton (1954)

c) Attitude Scales - Likert

Among attitude scales, the most popular scale technique is the Likert type attitude scale. Likert's technique requires items having the characteristic that the more favorable the pupil's attitude toward the item, the higher the expected score for the item. Pupils respond by indicating their reactions to items by means of a five point rating system: strongly agree, agree, undecided, disagree, strongly disagree. Items are then scored by assigning values of 5, 4, 3, 2, 1 respectively. This scoring is reversed for negatively worded items. Some variations of the Likert scale have three or seven points within the rating scheme. The Likert procedure yields fairly reliable scales, but their validity depends upon each particular scale and its orientation. The Aiken (1972), Suydam-Trueblood (1969) and Dutton (1968) Mathematics Attitude Scales are presented in figures 5-7, respectively.

Fennell (1976) has adapted the Likert technique to assess attitude

Figure 5
Mathematics Attitude Scale
Lewis R. Aiken

Directions: Please write your name in the upper right-hand corner. Each of the statements on this opinionnaire expresses a feeling or attitude toward mathematics. You are to indicate, on a five-point scale, the extent of agreement between the attitude expressed in each statement and your own personal feeling. The five points are: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), Strongly Agree (SA). Draw a circle around the letter or letters giving the best indication of how closely you agree or disagree with the attitude expressed in each statement.

1.	I am always under a terrible strain in a mathematics class.	SD	D	U	A	SA
2.	I do not like mathematics, and it scares me to have to take it.	SD	D	U	A	SA
3.	Mathematics is very interesting to me, and I enjoy arithmetic and mathematics courses.	SD	D	U	A	SA
4.	Mathematics is fascinating and fun.	SD	D	U	A	SA
5.	Mathematics makes me feel secure, and at the same time it is stimulating.	SD	D	U	A	SA
6.	My mind goes blank and I am unable to think clearly when working mathematics.	SD	D	U	A	SA
7.	I feel a sense of insecurity when attempting mathematics.	SD	D	U	A	SA
8.	Mathematics makes me feel uncomfortable, restless, irritable, and impatient.	SD	D	U	A	SA
9.	The feeling that I have toward mathematics is a good feeling.	SD	D	U	A	SA
10.	Mathematics makes me feel as though I'm lost in a jungle of numbers and can't find my way out.	SD	D	U	A	SA
11.	Mathematics is something that I enjoy a great deal.	SD	D	U	A	SA
12.	When I hear the word mathematics, I have a feeling of dislike.	SD	D	U	A	SA
13.	I approach mathematics with a feeling of hesitation, resulting from a fear of not being able to do mathematics.	SD	D	U	A	SA
14.	I really like mathematics.	SD	D	U	A	SA
15.	Mathematics is a course in school that I have always enjoyed studying.	SD	D	U	A	SA
16.	It makes me nervous to even think about having to do a mathematics problem.	SD	D	U	A	SA
17.	I have never liked mathematics, and it is my most dreaded subject.	SD	D	U	A	SA
18.	I am happier in a mathematics class than in any other class.	SD	D	U	A	SA

19.	I feel at ease in mathematics, and I like it very much.	SD	D	U	A	SA
20.	I feel a definite positive reaction toward mathematics; it's enjoyable	SD	D	U	A	SA

Aiken (1972)

Figure 6
Attitude Toward Mathematics Scale

Marilyn N. Suydam
Cecil R. Trueblood

This is to find out how you feel about mathematics. You are to read each statement carefully and decide how you feel about it. Then indicate your feeling on the answer sheet by marking.

A - if you strongly agree
B - if you agree
C - if your feeling is neutral
D - if you disagree
E - if you strongly disagree

1. Mathematics often makes me feel irritable and angry.
2. I usually feel happy when doing mathematics problems.
3. I think my mind works well when doing mathematics problems.
4. When I can't figure out a verbal problem, I feel as though I am lost in a mass of words and numbers and can't find my way out.
5. I avoid mathematics because I am not very good with numbers.
6. Mathematics is a stimulating and interesting subject.
7. My mind goes blank and I am unable to think clearly when working mathematics problems.
8. I feel sure of myself when doing mathematics.
9. I sometimes feel like running away from my mathematics problems.
10. When I hear the word mathematics, I have a feeling of dislike.
11. I am afraid of mathematics.
12. Mathematics is fun.
13. I like anything with numbers in it.
14. Mathematics problems often scare me.
15. I usually feel calm when doing mathematics problems.
16. I feel good toward mathematics.
17. Mathematics tests always seem difficult.
18. I think about mathematics problems outside of class and like to work them out.

19. Trying to work mathematics problems makes me nervous.

20. I have always liked mathematics.

21. I would rather do anything else than do mathematics.

22. Mathematics is easy for me.

23. I dread mathematics.

24. I feel especially capable when doing mathematics problems.

25. Mathematics class stimulates me to look for ways of applying mathematics to solving practical problems.

26. Time drags in a mathematics lesson.

in Bechtel (1969)

Figure 7
Attitude toward Arithmetic Scale
Wilbur H. Dutton

Attitude Scale

Grade in School _____ Age _____ Years _____Months
Name of School _____ Male _____ Female _____
Date of test _____ 19 ___

Read the statements below. Decide whether you strongly agree (SA), agree (Ag), are undecided (Und), disagree (DIS), or strongly disagree (SD). Then put a check in the corresponding blank. All of the statements have to do with the new mathematics that you are studying.

1. Working with numbers is fun.
2. Arithmetic should be avoided whenever possible.
3. Discovering the solutions to mathematical problems is exciting.
4. Arithmetic is good because it makes you think.
5. It is fun to think about problems outside of class.
6. Word problems are frustrating.
7. Doing arithmetic problems is boring.
8. One cannot use mathematics in daily life.
9. Arithmetic is very interesting.
10. Discovering solutions to mathematical problems is frustrating.
11. Arithmetic is a stimulating activity.
12. Arithmetic is too complicated.
13. Arithmetic is logical.
14. Arithmetic is necessary in daily life.
15. There are too many steps needed in getting the answer to a problem.
16. There are too many chances to make a mistake in arithmetic.
17. Arithmetic is practical.
18. Arithmetic takes too long.
19. Working with numbers presents a challenge.
20. Most word problems are not practical.
21. New mathematics is frightening.
22. Arithmetic is a waste of time.
23. It is fun to play with numbers.
24. There are too many rules to learn in arithmetic.
25. Discovering the solutions to mathematics is rewarding.
26. Two things I like about mathematics are.

    a. _____.

    b. _____.

27. Two things I dislike about mathematics are.

    a. _____.

    b. _____.

Dutton and Blum (1968)

toward a clinical mathematics setting. The scales presented in Figure 8 and 9 present attitude scales developed specifically for primary and intermediate-middle grade clinical pupils. The primary grade scale (Figure 8) utilizes a three point Likert scale. Three options were used since it seemed unreasonable to ask primary grade pupils to make distinctions between "Agree" and "Strongly Agree", etc. The three point response pattern is also used in the Survey of School Attitudes (1975).

The intermediate-middle grade General Attitude Toward Mathematics and the Clinical Mathematics Program Scale is a traditional 5 point Likert-type scale. Both Fennell Scales report content validity, high reliability, and moderate construct validity.

d) Semantic-Differential

The semantic differential technique is a method for measuring the meaning of an object to an individual; its use in assessing attitude represents a special application of the technique (Shaw, and Wright, 1967). In completing semantic-differential items the respondent rates a series of seven point bi-polar scales. Each item appears as follows:

Math class is:

fun ___ ___ ___ ___ ___ ___ ___ boring

worthless ___ ___ ___ ___ ___ ___ ___ valuable

Pupils are asked to check the position indicating their feeling toward the item(s). Scores are derived by assigning integral weights to each position on the scale.

Any formal attitude assessment technique must carefully consider measurement and evaluation concerns related to validity, reliability, and practicality. All scales presented in this paper have documented measures of reliability and validity. The thrust of this report is such that

Figure 8
General Attitude Toward Mathematics
and the Clinical Mathematics Program

F. M. Fennell

This is to find out how you feel about mathematics. You are to read each statement carefully and decide how you feel about it. Then indicate your feeling on the answer sheet by marking. This is to be orally administered.

strongly agree

so-so
eh

strongly disagree

1. Finding answers is fun.
2. I think when I do math.
3. You can't use math in daily living.
4. I feel sure of myself when doing math in the clinic.
5. Math is fun.
6. I don't like to play math games.
7. Math tests always seem hard.
8. I like to do math at my school.
9. Time drags in math classes at the clinic.
10. I would rather do anything else than do math.
11. I like my clinic math teacher.
12. I have always liked math.
13. Math seems easy for me at the clinic.
14. The clinic has not helped me in math.
15. I don't want to come to the math clinic ever again.

Figure 9
General Attitude Toward Mathematics
and the Clinical Mathematics Program

F. M. Fennell

This is to find out how you feel about mathematics. You are to read each statement carefully and decide how you feel about it. Then indicate your feeling on the answer sheet by marking.

A - if you strongly agree
B - if you agree
C - if your feeling is mutual
D - if you disagree
E - if you strongly disagree

1. Working with numbers in the math clinic is fun.
2. Mathematics should be avoided whenever possible.
3. Solving math problems in the clinic is exciting.
4. Math is good, because it makes you think.
5. You can't use math skills in daily life.
6. I think my mind works well when doing math problems.
7. I feel sure of myself when doing math in the clinic.
8. Math is fun.
9. Doing math problems in the clinic is boring.
10. Math tests always seem difficult.
11. I like to do math at my school.
12. Time drags in math classes at the clinic.
13. I would rather do anything else than do math.
14. I like my clinic math teachers.
15. I hate math sentence problems.
16. I have always liked math.
17. Math seems easy for me at the clinic.
18. I don't like the games at the math clinic.
19. The clinic has not helped me in math.
20. I don't want to come to the math clinic ever again.

measurement data will not be presented but will be made available to those requesting such information.

In reviewing techniques for assessing mathematics attitude it's imperative that clinical mathematics programs consider a systematic program of affective assessment. Periodic interviews, observations, and self-reporting may become the affective components of the clinical assessment program. It is suggested that systematic observation forms be filed on a weekly or daily basis, and structured interviews completed at least three times a week. Self-report procedures (attitude scales, or semantic differential) should be used at the beginning and end of the clinical experience. These suggestions may be adapted to specific areas of instructional and affective need. Clinical programs may consider developing affective measures that are closely aligned to individual program objectives and pupil needs. Whatever the basis for developing the affective assessment program, the assessment techniques should be selected and/or constructed with concern for essential measurement components, since affective evaluation results relate to the overall needs of clinical instruction.

Michaels and Forsyth (1978) describe the general facets of mathematics attitude as enjoyment, security and confidence, and appreciation of the usefulness and value of mathematics. Clinical mathematics programs should consider these general facets of attitude when shaping their affective assessment program.

Dutton (1954), Aiken (1970), and Knaupp (1973) all revealed that pupil attitude toward mathematics is more positive than negative at the elementary school level. Aiken's (1970) review of research indicated that a "very definite attitude toward mathematics may be formed as early as the third grade, but that math attitude may not be very stable in the early grades" (p. 557). Knaupp (1973) indicated that young children probably respond in terms of what they have been told about mathematics or in terms of their own experience in mathematics classrooms.

This information is especially valuable when considering affective growth among primary grade children. Aiken (1970) noted that scores on mathematic attitude scales may be better predictors of choice behavior, individual satisfaction, and perseverance than of achievement. It has also been shown that taking interests, attitude or level of anxiety into account in designing math achievement measures (tests or lessons) can improve performance.

Research, observations, the characteristics of the clinical mathematics student, and the need for accomplishment strongly suggest a well planned program of affective assessment as an integral component of the clinical mathematics program. Clinicians must strive to develop programs to adequately assess the affective avenues of growth.

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